Appendix B

Rule 132 Declaration B - **Regarding Professional Recognition of The Invention's Inventive Concepts**

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Applicant(s): Arthur, James D.

Examiner: Berhane, Adolf D., Art Unit 2838

Rule 132 Declaration B - **Regarding Professional Recognition of The Invention's Inventive Concepts**

James Arthur declares as follows:

1. I am the inventor in the above patent application.
2. EDN Magazine is one of the two leading trade journals of the electronics industry for design engineers, with an international circulation.
3. EDN Magazine includes a "Design Ideas" feature wherein novel and innovative circuit designs are published.
4. In the June 12, 2003 issue of EDN Magazine, the "Design Ideas" section, pg. 88, included an article entitled "LED driver delivers constant luminosity," by Isreal Schleicher. (attached copy: Exhibit B-1)
5. The Schleicher circuit employs the inventive concepts described in Applicant's specification, substantially identically as taught therein:
   a) an on-timer producing an on-time responsive to supply voltage Vcc, and
   b) an off-time established by the discharge of the switching inductor,

thereby producing a stabilized, single-cell boost converter for driving an LED.

6. I further declare that all statements made herein of my own knowledge are true and that all statements made upon information and belief are believed to be true, and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application and any patent issuing therefrom.

Signature | Date
James Arthur | November 8, 2005

James Arthur

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EXHIBIT B-1

sure it does not saturate at the highest value of peak current. Switching transistor Q_1 should have very low saturation voltage to minimize losses and produce the highest possible peak current. The addition of D_3 and C_4 enables the circuit to generate an auxiliary supply voltage, V_{AUX}, which you can use to drive low-power circuitry without adversely affecting the LED's intensity. With a battery voltage of 1V, the test circuit produces good light intensity in the white LED and delivers almost 1.5 mA at 4.7V to the auxiliary load. Even at V_{BATT}=500 mV, the circuit delivers 340 μA into a 10-kΩ load and maintains reasonable LED brightness. Note that IC_1 cannot take power from the auxiliary rail, because V_{AUX} can easily exceed the maximum voltage rating of the two suggested device types.

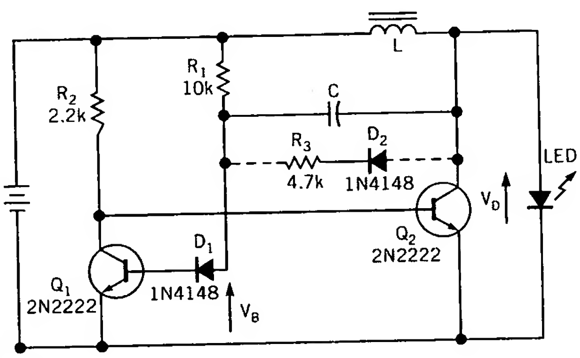
The minimum start-up voltage depends largely on the device you use for D_1. Tests using a high-quality Schottky diode produce a minimum power-up voltage of just 800 mV. You can further reduce this level by replacing D_1 with pnp transistor Q_2 (**Figure 1b**). This modification allows the test circuit to start up at just 650 mV at room temperature. Note, however, that Q_2's collector-base junction becomes forward-biased under quiescent conditions, which results in wasted power in its base-bias resistor. Despite its simplicity, the circuit can produce spectacular results with high-brightness LEDs. The Luxeon range of LEDs from Lumileds (www.lumileds.com) allows the circuit to demonstrate its prowess. With L_1 reduced to 10 μH and V_{BATT}=1V, the circuit generates a peak current of 220 mA in a Luxeon LXHL-PW01 white LED, resulting in dazzling light intensity.□

LED driver delivers constant luminosity

Israel Schleicher, Bakersfield, CA

The circuit in **Figure 1** is similar in principle to that of a previous Design Idea (**Reference 1**) but offers improved, more reproducible performance. The output current is almost constant over an input-voltage range of 1.2 to 1.5V and is insensitive to variations of transistor gain. Transistors Q_1 and Q_2 form an astable flip-flop. R_1 and C define the on-time of Q_2. During that time, Q_1 is off, and the voltage at the base of Q_1 and the current in inductor L ramp up. When the voltage at the base of Q_1 reaches approximately 0.6V, Q_1 turns on, and Q_2 turns off. This switching causes "flyback" action in inductor L. The voltage across the inductor reverses, and the energy stored in the inductor transfers to the LED in the form of a down-ramping pulse of current. During flyback time, voltage across the LED is approximately constant.

Figure 1



NOTE:
WHITE LED REQUIRES R_3 AND D_2.

This circuit delivers virtually constant luminosity for a white or a yellow LED.

The voltage for yellow and white LEDs is approximately 1.9 and 3.5V, respectively. When the current through the LED falls to zero, the voltage at the collector of Q_2 falls sharply, and this circuit condition triggers the next cycle. Assuming the justifiable approximation that the saturation voltage of Q_2 is close to 0V and that the LED's forward voltage, V_D, is constant, you can easily derive the expression for the average dc current through the LED:

$$I_{AVE} = \frac{V_{IN}^2 R_1 C}{2V_D L} \log_e\left(\frac{V_{IN}+V_D-V_B}{V_{IN}-V_B}\right).$$

At first glance, I_{AVE} depends strongly on V_{IN}. But close examination of the logarithmic term reveals that, with a proper selection of V_B, the logarithmic term can become a sharply declining function of V_{IN}. The logarithmic term thus fully compensates for the term V_{IN}^2 in the expression. That compensation is precisely the purpose of the diode, D_1, in series with the base of Q_1. The circuit drives a high-brightness yellow or white LED. **Table 1** shows the proper component selection for both colors. **Table 1** also shows some measured results at V_{IN}=1.35V. Because the voltage across the white LED falls from 3.9 to 3.1V during flyback, capacitor C subtracts current from the amount available to the base of Q_1. This subtraction might retrigger the circuit before the current in L falls to zero. The addition of R_3 and D_2 solves this problem. During flyback, the current that flows through R_3 compensates for the current withdrawn through C.□

TABLE 1—COMPONENT SELECTION FOR YELLOW OR WHITE LED

LED	L (mH)	C (pF)	D_1	Current drain (mA)	LED current (mA)	Frequency (kHz)	Power-conversion efficiency (%)
Yellow	1	470	1N4003	5.6	3.3±0.1	40	83
White	2	1800	1N752	12.4	3.7±0.2	15	78

Reference

1. Nell, Susanne, "Voltage-to-current converter drives white LEDs," *EDN*, June 27, 2002, pg 84.